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⑤④ **A building and building method.**

⑤⑦ A building, e.g. a hotel, is created by forming a framework having horizontal bearing structures, comprising different level bearing floors (1), and vertical bearing structures and positioning prefabricated room units (2) within the framework. Air gaps (9) for sound insulation are provided between the bearing structures and walls and ceilings of the room units.

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Fig. 1

The invention relates to a building according to the preamble of claim 1. In particular, but not exclusively, the framework of the building is made of concrete or of steel-reinforced concrete. In this specification the term steel-reinforced concrete framework refers either to a structure made entirely of steel reinforced concrete or to a structure of load-bearing columns and beams at least mainly made of steel and different level load bearing floors at least mainly made of concrete or steel-reinforced concrete.

A known building technique has been developed involving constructing a frame of the building relatively rapidly using mostly prefabricated supporting building elements. However, the interior of the building is still made mostly manually, which makes it expensive and time consuming. Further, planning the various stages of construction at the building site is difficult, because workers of different professions have different tasks to perform and the proper timing of these tasks demands accurate planning and time scheduling.

This known building technique also results in rooms of the building being poorly sound-insulated from each other. In particular noise is easily transmitted from one room to another through the building frame as a so-called "frame sound", the sound being transmitted both horizontally from one room to another on the same floor levels as well as vertically from one room to another on different floor levels. The problems caused by poor sound insulation can be reduced by employing special expensive sound insulating techniques, for example by building so-called floating floors. However normally with such multi floor buildings either rather poor sound insulation is accepted or the walls and floor levels are made thicker than required by the load stress for sound insulation purposes only.

The use of prefabricated room units is known per se. For example, in the shipbuilding industry it is known to instal prefabricated passenger cabins (see FI-62647, GB-A-1600110 and US-A-3363597). Also, prefabricated room units have been used previously in buildings as shown in US-A-2499498, US-A-3638380 and US-A-3823520. According to this known art, a frame is built to hold the room units in place, the room units forming the building itself and not being used to create the interior of a completed building. In US-A-2499498 a framework is shown for the temporary storage of movable room units. However these room units do not serve to finish the inside of the building.

The object of the invention is to solve several problems relating to the construction of buildings. The most important aims are to reduce the time taken to construct the interior of buildings, to construct much of the interior building remote from the building site, and to improve in a simple way the sound insulation of the building. The invention may also contribute to

improving the fire safety of buildings.

According to one aspect of the invention a building is characterised by the characterizing features of claim 1. The invention is mainly based on the fact that the actual room spaces and their interiors are built as prefabricated room units and are so installed that between the room units and the bearing structures of the building air gaps are provided which, in cooperation with the walls/ceilings of the room units, considerably improve the sound insulation between the insides of the various room units and adjacent bearing structures.

Buildings, e.g. a hotel building, made according to the invention can be constructed considerably faster than conventionally constructed buildings. It has been calculated that the building time of a hotel complex comprising about hundred rooms can be reduced by as much as five months by constructing the building in accordance with the invention. At the same time a very high level of interior decoration and fittings for the building can be achieved and sound insulation problems can be solved much more easily than in a conventional building.

Because in a house or building according to the invention the frame sounds can move from one to another room only through the floor, a considerable improvement in sound insulation is achieved just because of this. Today it is a normal requirement that the sound insulation between rooms should be at least 52 dB. In order to achieve this value the insulation of intermediate walls in a conventional concrete frame building must be about 60 dB, whereas in a building according to the invention it is sufficient for the total sound insulation in an intermediate wall structure to be about 53 dB. Because of this large difference, considerable savings can be made in the amount of building material used.

The invention can best be applied to a so-called column-beam-building in which the main bearing structures of the building are vertical columns and horizontal beams supported by the columns. The beams support the different level bearing floors which can take up conventional loads occurring on each floor level. Furthermore, the outer wall or another vertical wall structure of the building may comprise further vertical bearing structures of the building's supporting framework. In this case the floor level of the building is an open space including only some supporting columns, into which space the prefabricated room units can be installed.

Conveniently air gaps are also provided between two adjacent room units in order to achieve, in cooperation with the walls of the room units, a good sound insulation.

The sound insulation between the inside of a room unit and either the inside of an adjacent room unit or an adjacent bearing structure depends on the structure of the wall/ceiling of the room unit and the

size of the air gap adjacent the wall/ceiling. Since heavy mass is a very good barrier to airborne sound, the incorporation of heavy building material, e.g. sheet metal, plates or tiles of ceramic or stone material and plaster board (gypsum), in the wall/ceiling structure of a room unit which is adjacent a sound-insulating air gap greatly improves the sound insulation. Lighter building material, in particular mineral wool, should be used in the wall/ceiling structure in combination with the heavy material. A layer of mineral wool, possibly lined at its outside with paper, plastics, glass fibre fabric or the like, should be positioned adjacent the air gap, whereas the heavy building material should be positioned as far away as possible from the air gap, e.g. at or close to the inside of a wall/ceiling structure of the room unit.

A suitable width for the air gap is from 40 to 100 mm, preferably from 50 to 80 mm. A wider gap in cooperation with an adjacent room unit wall or ceiling usually provides better sound insulation, but, in order to save space, there is generally no need to use unnecessarily large air gaps. To prevent sound from being transmitted freely in the air gap network, the air gaps may, with advantage, be provided with non-rigid, e.g. soft, gap-closing elements of sound dampening material. Typically such a gap-closing element comprises a soft mineral wool strip applied across the air gap. Such gap-closing elements are useful also for improving fire safety, because they act as barriers within the air gap network for preventing the spread of fire or high temperatures therethrough.

Building costs are usually reduced most effectively by using bottomless room units, so that the bearing floors of the building form the floors of the room units. The room floors can be properly finished by adding floor coverings to the bearing floors. If extremely good sound insulation is required, it is better to use room units with their own floors instead of bottomless room units. However, in that case the costs are considerably higher.

For space saving it is of advantage to use cellular, mainly rectangular room units. The basic rectangular form should, however, be slightly modified, so that, for instance, in some corners of the room unit a bevelling or some other recess is provided, the purpose of which is to leave room for the building's vertical bearing structures, e.g. support columns or the like. Also the basic rectangular form of the room units may be modified to leave suitable space for pipes and cables. If a room unit includes a bathroom or the like, it is usually of advantage to make space for the pipes and cables close to the bathroom unit. Since the room height in secondary room spaces, such as corridors and bathrooms, does not necessarily need to be as high as in actual living rooms, it is often of advantage to lower the ceiling height of these secondary spaces, or of either of two adjacent spaces, so that there will be a step in the ceiling through which air conditioning

ducts or the like may be connected.

An efficient and economical use of the building according to the invention requires that the room units are dimensioned according to a modular system suitable for the building structure. For practical reasons, the maximum length of the module is usually about 7 m and the largest preferable width is about 3.4 m due to transportation factors. In special cases even a width of 4 m can be considered. Room units smaller than the modules, for instance, WCs, bathrooms or the like, are preferably integrated into room units with modular dimensions. In practice this means that a modular room unit may be divided into two or several sub-portions.

During construction of the building, the room units can advantageously be brought into the building through an open outer wall of the framework. A room unit intended for location close to an outer wall can with advantage be provided beforehand with a building element forming a part of the outer wall. Alternatively, outer walls elements can separately be installed in the outer wall when all the room units of one particular floor have been accommodated within that floor.

If in a building a large number of rooms mainly of the same kind are required, such as hotel rooms or the like, it is usually of advantage to use two kinds of room units of generally the same size but one of which is, at least basically, a mirror image of the other one. By placing a room unit and its mirror unit always side by side the advantage is obtained that pipes and cables for both the room units can easily be connected to the same HPAC-pit passing vertically through the building. Also the length of the pipes and cables drawn to different places in the room unit can be minimized by using the mirror-installation mode.

Suitably the room units are made sufficiently stiff that they are self-supporting. This facilitates their transportation to the building site and their subsequent installation. The stiffness of the room unit should preferably be such that the room unit does not need to be separately supported in the building. The only support given to the room units by the building will then be the support of the bearing floors. The lack of other supports will have a positive effect on the sound insulation. Exceptionally large room units may also be brought to the building site in parts.

Other aspects of the invention relating to a method of creating an interior of a building and to a method of creating a building are disclosed in claims 15 to 17.

Embodiments of the invention will now be described, by way of example, with particular reference to the accompanying drawings, in which

Figure 1 is a vertical section through a part of a building according to the invention, and

Figure 2 is a horizontal section of a part of a floor level of a building according to the invention.

Figure 1 shows primarily only different level bearing floors 1 of a framework of a concrete house building. Between the floor levels, a number of prefabricated room units 2 are arranged, each having walls indicated by reference numeral 3 and a ceiling indicated by reference numeral 4. The illustrated room units 2 are bottomless with exception of the wash and WC department 5, where a floor 6 has been installed during manufacture of the room unit. The floor 6 of the wash and WC department 5 is shown in Figure 1 only schematically. Usually it is somewhat above the average floor level of the building and is provided with a drain including sewer pipes and with other required equipment, for instance floor warming means.

The outer wall of the building consists partly of outer wall elements 7 connected to room units 2, which elements may include a window 8, a balcony door or anything else serving the building. The outer wall element 7 can be affixed to the room unit 2 at the manufacturing stage of the latter or, alternatively, the outer wall element 7 can be installed into the outer wall after the installation of the room unit 2.

It is important to arrange air gaps 9 between the room units 2 and adjacent bearing structures of the building. Each air gap 9, in cooperation with the wall or ceiling of the room unit concerned, provides an effective sound insulation between the room unit and the adjacent bearing structure. If, as shown in Figure 1, there is a corridor or similar public space to the right of the room unit, a thin panel wall 10 may be installed between the room unit and the corridor.

Usually there is a small entrance portion at one end of the room unit and beside it a wash and WC department 5 as shown in Figure 1. In this portion of the room unit the ceiling height may be somewhat lower than in the actual room space of the room unit. This is of advantage because the difference in ceiling height may, as shown in Figure 1, be used, for instance, for accommodating air conditioning ducts or tubing 11 supplied to the room unit.

Figure 2 shows, for instance, how the interior of an entire hotel floor may be formed according to the invention. In forming the interior, two types of room unit 2a and 2b, which are mirror images of each other, are used. When placing mirror image room units one adjacent to the other in a row, the advantage is obtained that pipes to be connected to the wash and WC departments 5, which have been integrated into the room units already in the manufacturing phase, may be located to the same pit 12, to which also other required service lines, e.g. air conditioning pipes, electric cables etc., are located.

Support columns of the building framework have been indicated by the reference numeral 13. By providing the room units with a corner bevelling 14, so dimensioned that the column 13 is located in the space provided by the bevelling, the advantage is obtained that virtually all of the available floor space

area is used. Because there is normally room for two room units between two support columns 13, there is also the advantage, in placing the room units in mirror unit pairs, that the corner bevelling is always facing a support column.

The interior of the building is created during construction of the building by moving the prefabricated room units through open outer wall openings of the framework. For example, the room unit 2a is moved in first and is then moved slightly to one side so that the column 13 is positioned in the corner bevelling of the room unit. After this, the mirror image room unit 2b is placed adjacent room unit 2a. Between all room units there is an air gap 9. After the installation of the room units, proper supplemental wall elements 15 are placed in the outer wall in front of the support column 13 and, if required, also in front of the gaps between a pair of room units.

Normally the room units are manufactured so that the supporting parts of the walls and ceilings are made of bent steel sheets, typically from about 0.7 mm to 1.00 mm thick. To one side of the steel sheet a mineral wool layer, typically about 15 mm thick, is glued. However if required, the mineral wool layer may be considerably thicker. The density of the mineral wool is preferably greater than 200 kg/m³. The metal surface side of the wall structure is arranged towards the inside of the room unit and the mineral wool insulation is towards the air gap between the room units. If the sound insulation of the wall structure is to be improved, this is most conveniently achieved by increasing the amount of heavy building material in the wall structure in such a part that is as far as possible from the air gap. Such a heavy building material can be, for instance, a plaster board or Dutch-tile or the like. Alternatively, if tiles or the like are not used, the side of the steel sheet which is facing the inside of the room unit, is usually covered with a suitable surface material, such as textile, plastic or the like.

It is not essential that each air gap is completely free of mechanical contact. A light contact within limited areas between, for instance, a layer of mineral wool and a supporting column, e.g. such as between items 13 and 14 in Figure 2, is not important. However in general there should be an air gap covering most of the outside surfaces of a room unit. If there is a part of the building framework close to a room unit, then there should be an air gap present between the wall and/or ceiling of the room unit and the adjacent framework part.

Claims

1. A building having a framework of horizontal bearing structures, comprising bearing floors (1), and vertical bearing structures (13) and rooms (5) within the framework, characterised in that said

rooms are formed from prefabricated room units (2) each including at least walls (3) and a ceiling (4) and in that air gaps (9) are provided between said bearing structures and at least some of said walls and/or ceilings, which air gaps (9), in cooperation with associated room unit walls or ceilings, form sound insulation with respect to adjacent framework bearing structures.

2. A building according to claim 1, characterised in that at least some of said bearing structures are made of concrete and/or steel-reinforced concrete.
3. A building according to claim 1 or 2, characterised in that said horizontal bearing structures comprise beams supporting said bearing floors.
4. A building according to claim 1, 2 or 3, characterised in that additional air gaps are formed between adjacent walls of adjacent pairs of room units to form, in cooperation with said adjacent walls, sound insulation between the adjacent pairs of rooms.
5. A building according to any of the preceding claims, characterised in that at least some of said room units are at least partly floorless and in that a floor or floors for each at least partly floorless unit room unit is provided by an appropriate covering applied to the bearing floor on which the room unit is supported.
6. A building according to any of the preceding claims, characterised in that at least some of said room units are of cellular form and at least some of said cellular room units has a vertically extending recess (14) at at least one of its corners in which is received at least one of said vertical bearing structures.
7. A building according to any of the preceding claims, characterised in that at least some of said room units are dimensioned to fit into a modular system and are sub-divided into smaller prefabricated rooms.
8. A building according to any of the preceding claims, characterised in that at least some of said room units have outer walls at the periphery of the building, at least some of said outer walls having outer wall elements fitted thereto during fabrication of the room units defining outside wall elements of the building.
9. A building according to any of the preceding claims, characterised in that at least some of said room units are arranged in rows, each row com-

prising adjacent pairs of room units, the two room units of a pair being structural mirror images of each other.

- 5 10. A building according to any of the preceding claims, characterised in that the air gap width is from 40 to 100 mm, preferably from 50 to 80 mm.
- 10 11. A building according to any of the preceding claims, characterised in that the room units are sufficiently rigid to be supported only from below by means of the bearing floors.
- 15 12. A building according to any of the preceding claims, characterised in that the vertical bearing structures comprise columns or the like extending between the vertically spaced apart bearing floors.
- 20 13. A building according to any of the preceding claims, characterised in that at least some of said air gaps are subdivided by installation in the air gaps of soft sound dampening material.
- 25 14. A building according to any of the preceding claims, characterised in that at least some of said ceilings are stepped with a step portion joining upper and lower ceiling portions, and in that at least one air conditioning conduit extends over the lower ceiling portion to the step portion for communication with the inside of the associated room unit.
- 30 15. A method of creating an interior of a building comprising providing rooms within a framework of horizontal and vertical bearing structures, characterised in that said rooms are provided by arranging within said framework prefabricated room units, each including at least walls and a ceiling, on bearing floors constituting said horizontal bearing structures, the room units being arranged so that air gaps are formed between said bearing structures and at least some of said walls and/or ceilings to form, in cooperation with the adjacent structural parts of the room units, effective sound insulation between the interiors of the room units and adjacent bearing structures of the building framework.
- 40 16. A method of creating a building comprising forming a framework of horizontal and vertical bearing structures and providing rooms within the framework, characterised in that said rooms are provided by arranging prefabricated room units, each including at least walls and a ceiling, on bearing floors constituting said horizontal bearing structures, the room units being arranged so that air gaps are formed between said bearing struc-
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tures and at least some of said walls and/or ceilings to form, in cooperation with the adjacent structural parts of the room units, effective sound insulation between the interiors of the room units and adjacent bearing structures of the building framework. 5

17. A method of creating an interior of a building having a framework made of concrete or of steel-reinforced concrete, thereby providing the building with planned bedrooms, dining rooms, dwelling rooms and/or planned special rooms such as kitchen, sauna, bathroom and WC-room, characterised in that said rooms are formed of prefabricated room units including at least walls and a ceiling and that these room units are so placed in the building that outside at least some of the walls and/or the ceiling of the room unit an air gap is formed between the room unit and bearing structures of the building, which air gaps, in cooperation with the adjacent structural parts of the room units, form an effective sound insulation with respect to any adjacent bearing portions of the building. 10 15 20

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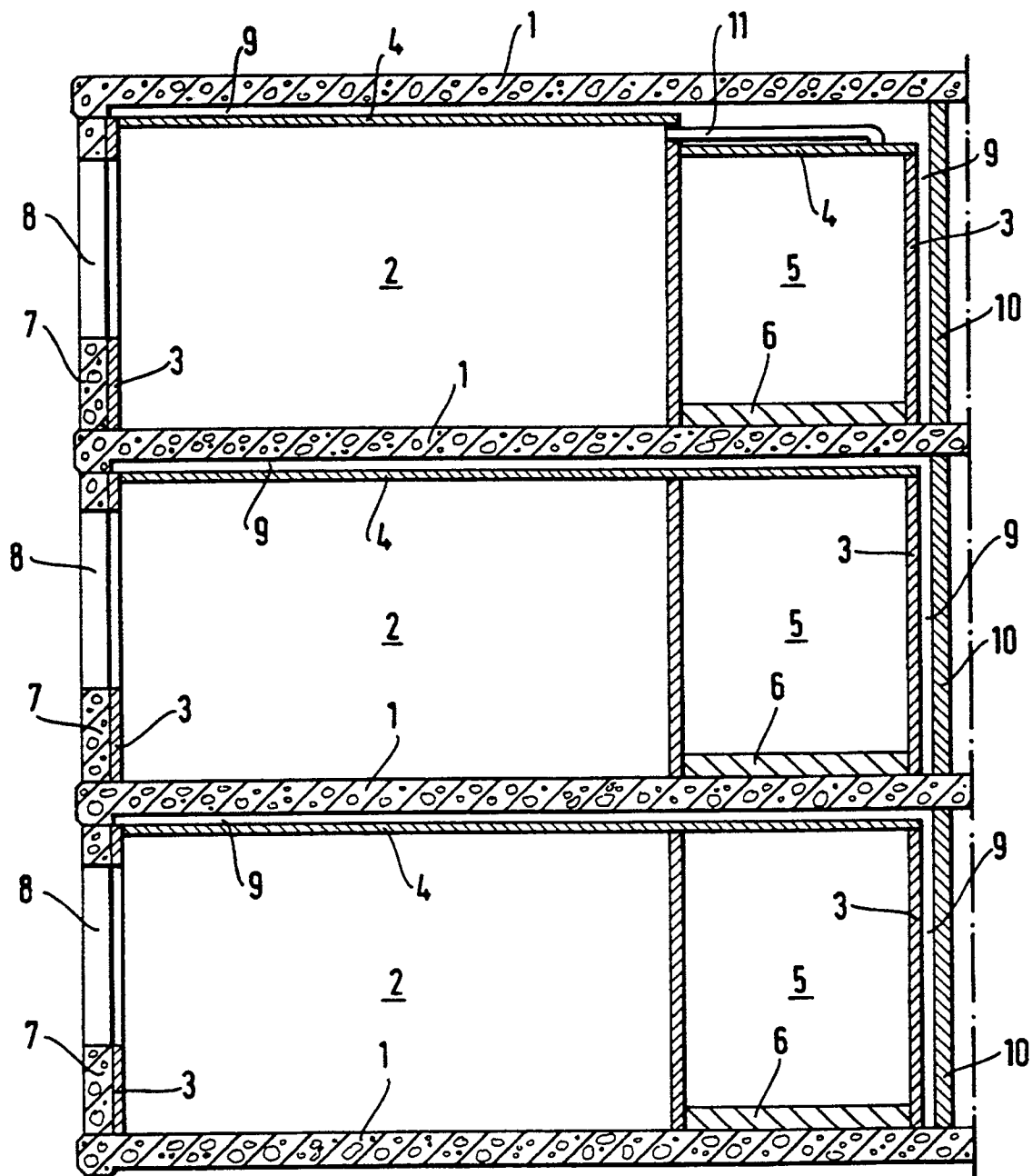
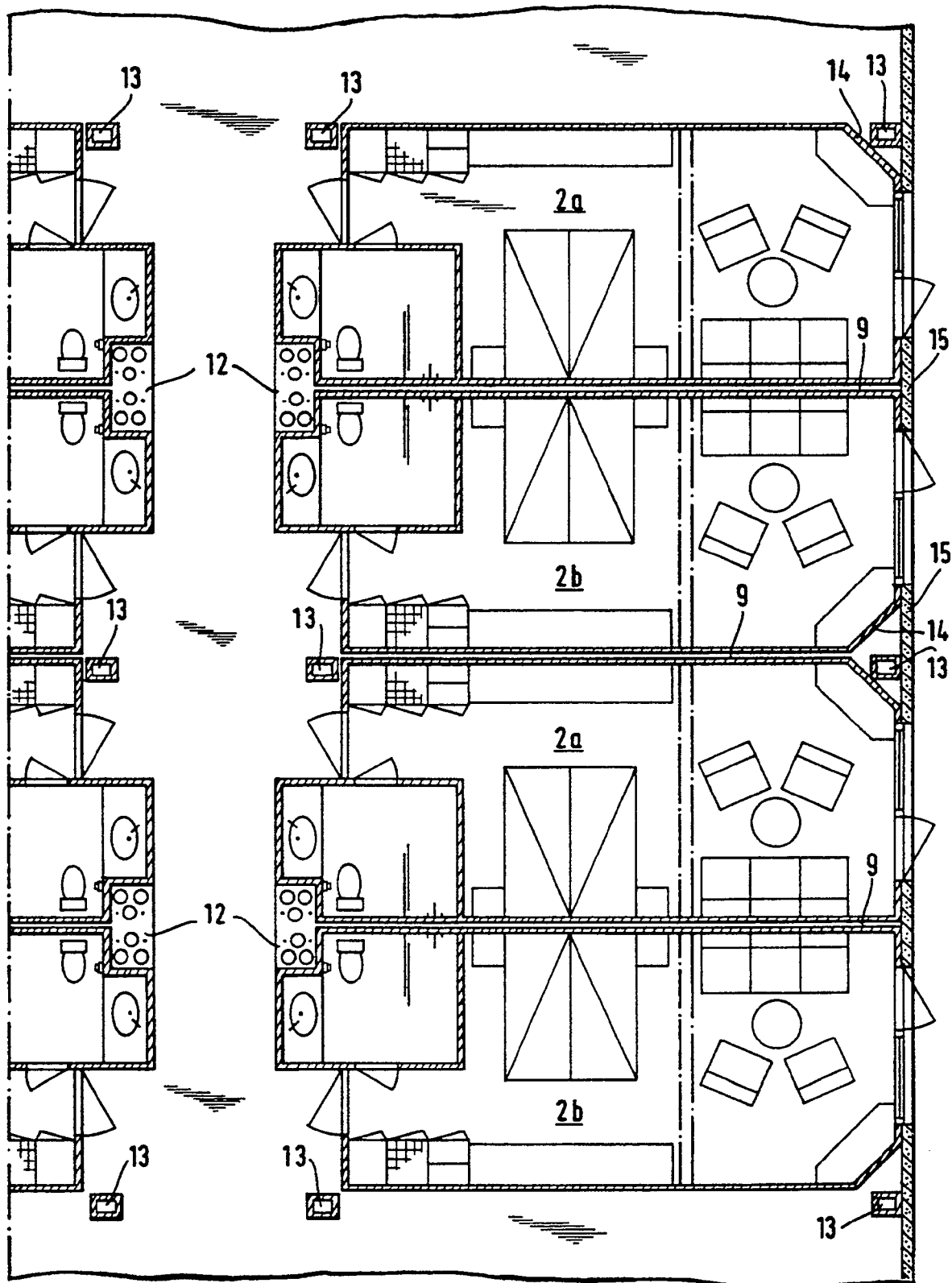


Fig. 1

Fig. 2





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 91 30 5491

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	FR-A-1 372 468 (J. J. DE MAILLY) * the whole document *	1-5, 7-17	E04B1/348
X	FR-A-1 265 925 (P. BOUCHET) * the whole document *	1-5, 7-14	
Y	---	6, 15-17	
Y	DE-A-2 219 202 (HEINLE ET AL.) * page 8, paragraph 4 - page 10, paragraph 1; figures 1-3 *	6	
A	---	1	
Y	DE-A-2 719 953 (G. VIVIANI) * the whole document *	15-17	
A	---	1	
A	FR-A-2 101 192 (E. J. KUMP) * page 4, line 27 - line 36; figures 2, 3 *	1, 6	
A	BE-A-844 795 (J. L. G. MARTIAL) * page 2, paragraph 6 *	1	
A	GB-A-1 095 449 (A. E. Q. VAN HEZIK) ---		
A	EP-A-0 118 957 (BUREAU BOUWCOÖRDINATIE NEDERLAND B.V.) -----		E04B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 10 SEPTEMBER 1991	Examiner KAPPOS A.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application I : document cited for other reasons & : member of the same patent family, corresponding document			

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